Ground Fault Detection in Semiconductor Fabrication Equipment

The process of making semiconductor chips is extremely complex with the size of the chips shrinking while the number of transistors on each chip continues to increase. The process involves using the purest silicon available (one atom of foreign material in one billion atoms of silicon) as any impurities can cause fallout. Much of the design of the machines fabricating the silicon wafers into chips is addressed by the standards developed by the global industry association SEMI. Its standard S22-071b provides guidelines regarding the safety of the equipment. Many hazardous chemicals are used to clean the wafers and etch the various layers of substrate so the end products are the reliable electronic devices we have become so dependent upon. The need for standards applicable to this industry points to how diverse the processes are when compared with many other industries. SEMI understands the importance of worker safety, hence the standards are more stringent than in many other industries.

A typical installation of ground fault sensors monitoring several heating circuits used in the semiconductor fabrication process. If a fault to earth is detected, the latching output sensor de-energizes the contactor coil, turning off the offending circuit.

The temperatures used in the chip making process range from dangerous (boiling water levels) to extreme. The temperatures used to cure the photoresist compounds are not unusual for other industries at 80–100 °C, but the wafers are annealed in furnaces or through rapid thermal annealing (RTA) to 1000°C or higher, nearly the melting point of steel (1350°C). Most of these processes use electrical heat sources as there is no combustion exhaust or burnt fuel wastes. The ability to control temperature precisely is very desirable. For example, with RTA the wafer is brought to a very high temperature in a few seconds using high intensity lamps or lasers, and then cooled much more slowly to reduce fracture and warping of the wafer. The processes of deposition of layers and coatings to the wafers are quite varied, and are done in the presence of specific gases or in a vacuum. The coating of the silicon has various purposes, from physical protection from damage to insulation between conducting elements.

The SEMI standards cover a wide range of issues, and many are covered by Emergency Mains Off (EMO) circuitry design. If there is any problem during the processing of the wafers, the operator is able to turn of the mains power by pushing some buttons. With the number of electrical heating elements used is various places in the fabrication equipment, the need for ground fault protection is obvious to the equipment designers. The elements are monitored in each process segment, with fault detectors set at a fairly low trip point. If there is a fault to earth through the heating element, these sensors will shut down that part of the process separately from the entire machine. If there is a major catastrophe and several heating processes short at one time, a sensor with a bit of delay and higher trip point will shut off the main power feed.

AG and AGL Series Ground Fault Sensors

AG Series ground fault detectors monitor all current-carrying conductors in grounded single- and three-phase delta or wye. Single factory calibrated setpoints are available from 5 mA to 950 mA. Field-selectable 5 mA, 10 mA or 30 mA setpoints on the AG3 "Tri-set" model makes user adjustments fast, sure and convenient. Available with a choice of N.O. or N.C solid-state switch or mechanical relay outputs systems. AGL Series detectors are large aperture ground fault relays that offer one of the largest aperture diameters in the industry while maintaining a compact overall profile. Intended for sensing earth leakage in applications up to 300 A, the AGL Series offers a choice of N.O. or N.C. latching relays or an SPDT Form C relay with auto-reset. Enclosure features integral DIN rail mounting as standard. Both series offer an optional noise-immunity coatings for applications in harsh EMI/RFI environments.

NK Technologies
3511 Charter Park Drive • San Jose, CA 95136
800.959.4014 • www.nktechnologies.com • sales@nktechnologies.com

FIVE YEAR 5 WARRANTY
RoHS 2 COMPLIANT